Evidence-Based Guidelines for Utilization of Dexamethasone Iontophoresis

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Iontophoresis involves transmission of ionized medicated and non-medicated substances into the skin. An electrical field is produced between two electrodes that have opposite polarities, which either repel or attract ions within a medication. The basic principle underlying iontophoresis is that opposite charges attract each other and like charges repel each other. Thus, medications with a positive charge will be repelled by an electrode with positive polarity (anode), and those with a negative charge will be repelled by an electrode with negative polarity (cathode). Lachaud studied the use of corticosteroids in iontophoresis, which led to the use of dexamethasone as the primary anti-inflammatory medication administered through iontophoresis treatments. Common medications used to treat orthopedic conditions through iontophoresis include dexamethasone, acetate, hydrocortisone, and lidocaine.

Dexamethasone is a common iontophoresis medication used by athletic trainers because of its anti-inflammatory properties and the availability of a noninvasive mechanism to deliver a localized concentration of the medication. The purposes of this report are to review the current research evidence pertaining to dexamethasone iontophoresis and to provide practice guidelines for its use in athletic training.

Using Dexamethasone to Treat Inflammatory Conditions

Researchers have assessed the effectiveness of dexamethasone iontophoresis for treatment of inflammatory conditions such as carpal tunnel syndrome, lateral epicondylitis, Achilles tendon pathology, and plantar fasciitis. There are a wide variety of treatment protocols using dexamethasone iontophoresis. Effective treatment depth has been found to be <30 mm below the skin’s surface.

Key Points

- Dexamethasone iontophoresis has been shown to be effective for inflammatory conditions, such as carpal tunnel syndrome, lateral epicondylitis, Achilles tendon pathology, and plantar fasciitis.
- There are a wide variety of treatment protocols using dexamethasone iontophoresis.
- Effective treatment depth has been found to be <30 mm below the skin’s surface.
between the treatment group and the placebo group was reported for any of the outcome measures, suggesting that dexamethasone treatment was no better than placebo.

Runeson and Haker⁹ found no statistical difference in pain-relief between the treatment and control groups that consisted of 65 patients suffering from lateral epicondylitis. In contrast, Nirschi et al.¹⁰ found that dexamethasone iontophoresis significantly reduced short-term pain and inflammation in 99 patients suffering from acute epicondylitis when compared to a control group of 100 patients.

Neeter et al.¹¹ found that management of Achilles tendon pain with dexamethasone iontophoresis was effective in reducing pain at six months compared to a control group. Gudeman et al.¹⁴ found that patients with plantar fasciitis who were treated with dexamethasone iontophoresis had decreased pain and increased foot function after one week of treatment compared to a placebo group; however, those who received the dexamethasone iontophoresis treatment did not demonstrate a significant difference in pain and function compared to the placebo group after one month, which suggests that the treatment had only short-term effectiveness. Osborne and Allison¹² found that acetic acid iontophoresis was more effective in controlling plantar fasciitis pain than both dexamethasone iontophoresis and placebo treatments. Contrary to the above studies, Cleland et al.¹³ compared dexamethasone iontophoresis to manual therapy (tissue mobilization and joint mobilization of the ankle, knee, and hip) for treatment of plantar heel pain. Although dexamethasone iontophoresis was effective in increasing ankle function, it was not as effective as manual therapy, and it did not produce change in status that exceeded the Minimal Clinically Important Difference (MDIC) for meaningful improvement.

Evidence-Based Treatment Parameters

The practice of athletic training is becoming increasingly reliant on evidence-based guidelines.¹⁵ Table 2 summarizes evidence-based treatment parameters for use of dexamethasone iontophoresis to treat inflammatory conditions.

Iontophoresis treatment dosage is typically measured in milliamp-minutes (mA-minutes), which is derived from multiplication of the minutes of treatment by the current intensity (amplitude). For example, if a patient was treated for 20 minutes at 4 mA amplitude, then the total treatment dosage would be 80 mA-minutes. Treatment dosages for use of dexamethasone to treat inflammatory conditions are equal to, or less than, 80 mA-minutes.³,⁷⁻¹⁰,¹²⁻¹⁴ Setting the treatment dosage above 80 mA-minutes can cause skin burns.¹⁶,¹⁷ Dexamethasone concentration of 0.4% has been used by a number of researchers.⁶⁻¹⁰,¹²,¹⁴

Many iontophoresis units have preset limits on the amplitude or current that can be selected for treatment, and the current flow will automatically stop when the

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**Table 1. Summary of the Evidence Regarding Dexamethasone Iontophoresis and Inflammatory Conditions**

<table>
<thead>
<tr>
<th>Pathology</th>
<th>Dosage</th>
<th>Concentration</th>
<th>Current</th>
<th>Treatment Cycle</th>
<th>Benefit</th>
<th>Study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carpal Tunnel</td>
<td>*****</td>
<td>0.4%</td>
<td>*****</td>
<td>6 tx over 2 weeks</td>
<td>Yes</td>
<td>Gökoglu et al., 2005⁶</td>
</tr>
<tr>
<td></td>
<td>10-40 mA-min</td>
<td>0.4%</td>
<td>1-4 mA</td>
<td>5 tx over 3 weeks</td>
<td>Yes</td>
<td>Karatay et al., 2009⁷</td>
</tr>
<tr>
<td></td>
<td>80 mA-min</td>
<td>0.4%</td>
<td>2 mA</td>
<td>6 tx over 2 weeks</td>
<td>No</td>
<td>Amirjani et al., 2009⁸</td>
</tr>
<tr>
<td>Lateral Epicondylitis</td>
<td>40 mA-min</td>
<td>0.4%</td>
<td>4 mA</td>
<td>4 tx over 2 weeks</td>
<td>No</td>
<td>Runeson et al., 2002⁹</td>
</tr>
<tr>
<td></td>
<td>40 mA-min</td>
<td>0.4%</td>
<td>4 mA</td>
<td>6 tx over 2 weeks</td>
<td>Yes</td>
<td>Nirschl et al., 2003¹⁰</td>
</tr>
<tr>
<td>Achilles Tendon</td>
<td>*****</td>
<td>*****</td>
<td>*****</td>
<td>4 tx over 2 weeks</td>
<td>Yes</td>
<td>Neeter et al., 2003¹¹</td>
</tr>
<tr>
<td>Plantar Faciitis</td>
<td>40 mA-min</td>
<td>0.4%</td>
<td>1-4 mA</td>
<td>6 tx over 2 weeks</td>
<td>Yes</td>
<td>Osborne et al., 2006¹²</td>
</tr>
<tr>
<td></td>
<td>40 mA-min</td>
<td>*****</td>
<td>*****</td>
<td>4 tx over 2 weeks &amp; 2 tx over 2 weeks</td>
<td>No</td>
<td>Cleland et al., 2009¹³</td>
</tr>
<tr>
<td></td>
<td>40 mA-min</td>
<td>0.4%</td>
<td>1-4 mA</td>
<td>6 tx over 2 weeks</td>
<td>Yes</td>
<td>Gudeman et al., 1997¹⁴</td>
</tr>
</tbody>
</table>

***** Not stated in study
selected treatment dosage has been achieved. The maximum recommended treatment amplitude in the literature is 4 mA, but some patients have experienced discomfort with a treatment amplitude that is close to 4 mA. Treatment cycle refers to the volume of treatment administered over a period of days or weeks. For the treatment of carpal tunnel syndrome, Karatay administered five treatment sessions per week for three weeks. For treatment of plantar heel pain, Cleland administered two treatments per week for two weeks, which was followed by one treatment per week for two more weeks. Both Runeson, who was treating Achilles tendon pain, and Neeter, who was treating lateral epicondyle pain, identified four treatment sessions within two weeks, with three to four days between treatment sessions, as an effective treatment cycle. Five studies, two involving carpal tunnel syndrome, two involving plantar fasciitis, and one involving acute epicondylitis, used a treatment cycle consisting of six treatment sessions over a two-week period. On the basis of studies that have produced positive outcomes, a recommended treatment cycle consists of four to six treatment sessions over a period of two to three weeks.

**Depth of Penetration**

A central question about the effectiveness of iontophoresis is the depth of medication delivery. Several studies have demonstrated that iontophoresis delivers dexamethasone into the skin to a depth of 30 mm. Glasset et al. reported that 30% of a dexamethasone dose penetrated the skin to a depth of 6-20 mm after 100 mA-minutes (5 mA over 20 mins) of current delivery in Rhesus monkeys. The results of this study are difficult to generalize to a human population, because most of the current literature relates to research that has involved human subjects and doses up to 80 mA-minutes. Gurney and Wascher found that a measurable amount of dexamethasone had been transmitted through the skin and into human connective tissues at a treatment dose of 40 mA-minutes. Anderson et al. tested dexamethasone iontophoresis on five human subjects with a dosage of 40 mA-minutes and reported a penetration depth of 8-10 mm. The results of this study also suggested that prolonged treatment time increased the concentration of dexamethasone in the tissues, because passive diffusion was the main mechanism for movement of the medication through the skin. The collective findings of the cited studies suggest that dexamethasone can be delivered to tissues that are less than 30 mm from the skin surface.

**Conclusions**

Research evidence supports the use of dexamethasone iontophoresis for treatment of Achilles tendon pathology and plantar fasciitis. There is conflicting evidence regarding the effectiveness of dexamethasone iontophoresis to treat carpal tunnel syndrome and lateral epicondylitis. Only one study, however, has examined the effects of dexamethasone iontophoresis in athletic patients. Although two studies have used patients under the age of 40, the majority of the available research has involved patient populations beyond the age of 40. Generalizability of the study results to the athletic population may be limited by changes in skin permeability associated with aging. Additional research needs to be performed to assess the effectiveness of dexamethasone iontophoresis for the treatment of athletic injuries.

**References**


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