Short Term Analgesic Effects of 5% Dextrose Epidural Injections for Chronic Low Back Pain: A Randomized Controlled Trial

Liza Maniquis-Smigel, Kenneth Dean Reeves, Howard Jeffrey Rosen, John Lyftogt, Cassie Graham-Coleman, An-Lin Cheng, and David Rabago

Abstract

Background: Hypertonic dextrose injection (prolotherapy) is reported to reduce pain including non-surgical chronic low back pain (CLBP), and subcutaneous injection of 5% dextrose is reported to reduce neurogenic pain, hyperalgesia and allodynia. The mechanism in both cases is unclear, though a direct effect of dextrose on neurogenic pain has been proposed. This study assessed the short-term analgesic effects of epidural 5% dextrose injection compared with saline for non-surgical CLBP.

Methods: Randomized double-blind (injector, participant) controlled trial. Adults with moderate-to-severe non-surgical low back pain with radiation to gluteal or leg areas for at least 6 months received a single epidurogram-confirmed epidural injection of 10 mL of 5% dextrose or 0.9% saline using a published vertical caudal injection technique. The primary outcome was change in a numerical rating scale (NRS, 0 - 10 points) pain score between baseline and 15 minutes; and 2, 4, and 48 hours and 2 weeks post-injection. The secondary outcome was percentage of participants achieving 50% or more pain improvement at 4 hours.

Results and Conclusions: No baseline differences existed between groups; 35 participants (34 ± 10.7 years old; 11 female) with moderate-to-severe CLBP (6.7 ± 1.3 points) for 10.6 ± 10.5 years. Dextrose participants reported greater NRS pain score change at 15 minutes (4.4 ± 1.7 vs 2.4 ± 2.8 points; P = 0.015), 2 hours (4.6 ± 1.9 vs 1.8 ± 2.8 points; P = 0.001), 4 hours (4.6 ± 2.0 vs 1.4 ± 2.3 points; P < 0.001), and 48 hours (3.0 ± 2.3 vs 1.0 ± 2.1 points; P = 0.012), but not at 2 weeks (2.1 ± 2.9 vs 1.2 ± 2.4 points; P = 0.217). Eighty four percent (16/19) of dextrose recipients and 19% (3/16) of saline recipients reported ≥ 50% pain reduction at 4 hours (P < 0.001). These findings suggest a neurogenic effect of 5% dextrose on pain at the dorsal root level; waning pain control at 2 weeks suggests the need to assess the effect of serial dextrose epidural injections in a long-term study with robust outcome assessment.

Keywords: Analgesia, Epidural, Anesthesia, Caudal, Dextrose
tis (9) and a follow-up study suggested a direct sensorineu-
ral effect (15). Dextrose injections have also targeted super-
facial sensory nerves in uncontrolled and controlled stud-
ies (16-19). Anecdotal evidence from the authors’ clinics
(LMS and HJR) suggested that epidural injection of 5% dex-
trose in patients with chronic low back and leg pain is
associated with a rapid short-term analgesic response. How-
ever, this observation has not been empirically assessed.

2. Objectives

As part of a multi-method study, we conducted a ran-
domized controlled trial (RCT) to test the hypothesis that
participants with non-surgical CLBP with either buttock or
leg pain who received injection of 5% dextrose in the cau-
dal epidural space, compared with those who received nor-
mal saline injection, would report decreased pain within 15
minutes of injection lasting up to 2 weeks.

3. Methods

3.1. Study Design

This two-arm double-blind study was approved by
the Western Institutional Review Board, with ClinicalTri-
als.gov identifier of NCT01547364. A non-blinded research
assistant generated twenty randomly-permuted 2-person
blocks via computer (randomization.com) for use in 1 to
1 group assignment. The research assistant used this
password-protected list to consecutively allocate eligible
participants to either dextrose or normal saline injection.
The injector (LMS), participant, and outcome assessor were
masked to treatment group. At the injection session, the
research assistant consulted the allocation assignment list
and prepared 10 mL of either dextrose or NS at the point of
care in a separate room and presented the de-identified sy-
ringe to the blinded injector (LMS) for use on the blinded
participant.

3.2. Inclusion and Exclusion Criteria

Inclusion criteria included 19 to 75 years old; simul-
taneous participation in a concurrent patient study of a
vertical small needle caudal epidural injection technique
(20); 6 months or more of self-reported moderate-to-severe
CLBP including below the iliac crest as defined by a self-
reported score of 5 or more on a 0 - 10 Numeric Rating
Scale (NRS) in response to the question "What is the in-
tensity of your back pain?"; and failure of one or more
non-injection therapies. NSAID use was not considered a
modality of treatment. Exclusion criteria included pro-
gressive weakness; recent bowel or bladder dysfunction
concerning for unstable or progressive surgical CLBP; in-
crease in self-reported morphine equivalent dose of pre-
scription pain medication in the past 3 months; local in-
fected; unstable psychotic disorder; other chronic pain;
or current anticoagulation or medical condition render-
ing the potential participant unable to reliably participate
in the study.

Single injection Intervention: Participants were
treated in a prone position without an abdominal bolster
and without reverse Trendelenburg. Sterile preparation
of the injection site was with 2.3% chlorhexidine glu-
conate/24% isopropyl alcohol. A vertical short needle
technique was utilized for injection in the caudal epidural
space, using a 25 gauge 3.8 cm needle with needle entry at
or below the sacral cornua (20). A positive epidurogram
confirmed needle placement in the caudal epidural space.
After confirmation, 10 mL of solution was injected over
1 minute as tolerated by the participant, with pressure
sensation being the rate-limiting factor. Participants
remained prone for at least 5 minutes. No post-injection
analgesics were provided to participants. Participants
were allowed to continue current medication usage
during the 2-week period of the study.

3.3. Outcome Measures and Follow-Up

The primary outcome measure was a change in pain
score on a 0 - 10 numerical rating scale (NRS) in response
to the question "What is the intensity of your back pain?"
with anchors of 0 ("No pain") and 10 ("Most severe pain
imaginable"). The NRS has been demonstrated to be reli-
able (21). In chronic musculoskeletal pain, a reduction of
15% or one point in the NRS represents a minimal clinically
important difference (22). Participants pre-injection (base-
line) and 15-minute follow-up post-injection pain scores
were recorded in clinic and on a pre-printed pain-level-
recording card. Participants were instructed to record
their at-home pain levels at 2, 4 and 48 hours. They were
called by the office manager/assessor at the conclusion
of day 2 to report the pain levels indicated on their card
trough 48 hours. Their final in-person follow-up in this
study was at two weeks. Participants were informed of
their allocation assignment at two weeks; participants in
both groups were offered enrollment in an open label
study to assess the long-term effect of serial dextrose injec-
tions. Interested participants were enrolled; the study is
ongoing and results will be reported separately.

3.4. Other Measures

Age, sex, body mass index, pain severity, pain duration,
precription opioid use, medications for neuropathic pain,
and diagnostic category were collected at baseline to characterize the sample and to evaluate as covariates for statistical analysis. Participants were assigned to one of five diagnostic categories based on magnetic resonance imaging, electromyographic and physical examination criteria: lumbar spinal stenosis, lumbar radiculopathy, peripheral neuropathy, failed back surgery or nonspecific low back pain. (Figure 1)

Analysis: Using a projected between-group mean difference for improvement over time in NRS pain of 2.5 points on a 0 -10 scale and a standard deviation of 2.0 points, an effect size of 1.25 was calculated. Assuming 10% loss to follow-up, 32 participants would provide 90% power to detect a difference in mean NRS scores between dextrose and normal saline at a significance level of 0.05. Analysis was per protocol. Data were analyzed using PASW 18 (Predictive Analytics Software 18.0.0, IBM). Descriptive statistics describe outcomes at each time point; mean value ± standard deviation (SD) was reported at baseline. A ANCOVA for pain scale was applied to compare the groups for magnitude of change in the 0 -10 NRS pain score between baseline and follow-up for time points 15 minutes, 2, 4, 48 hours and 2 weeks. Preliminary observations suggested a maximal analgesic effect of epidural injection of dextrose at 4 hours. Efficacy studies on epidural injection for treatment of pain have defined a clinically relevant pain outcome of at least 50% improvement on the 0 - 10 NRS scale (23). Pearson chi square analysis was utilized to compare dextrose and saline groups for the percentage achieving ≥ 50% pain reduction at 4 hours, calculated by dividing the difference between baseline and follow-up scores by the initial score.

3.5. Presentation History

An abstract based on data from this clinical trial was presented as a poster at the annual meeting of American Congress of Rehabilitation Medicine, October 25-30, 2015, in Dallas, Texas.

4. Results

All participants were treated in Hilo, Hawaii, or Honolulu, Oahu, and were enrolled and treated between February 22, 2013, and November 12, 2013. Participation in the study was offered to the first 56 persons who met screening criteria (Figure 2). Nineteen declined participation. Thirty-seven were randomized. Nineteen received 5% dextrose and sixteen received normal saline injection into the caudal epidural space. Two participants complained of substantial cramping pain prior to receiving the full 10 mL injection volume. Both were exited from the study due to procedure intolerance, were unblinded at 15 minutes post injection, and determined to be in the saline group. There were no other adverse events. Data capture at 2-week follow-up was otherwise complete.

There were no significant baseline differences between groups (Table 1). The study sample was middle aged (54 ± 10.7 years) and 31% female; 77% were either pre-obese (BMI ≥ 25 kg/m²), or obese (BMI ≥ 30 kg/m²). Participants reported a mean of 10.6 ± 10.5 years of back pain. More than 50% were taking or had tried prescribed opioids. The most common primary diagnoses were lumbar spinal stenosis (34%), lumbar radiculopathy (26%) and nonspecific low back pain (26%). Pain severity was moderate to severe with a mean baseline pain level of 6.7 ± 1.3 points (range 5 to 9).

**Table 1. Baseline Participant Characteristics by Treatment Group**

<table>
<thead>
<tr>
<th>Non-Diagnostic Characteristics</th>
<th>Dextrose</th>
<th>Saline</th>
<th>P Valueb</th>
</tr>
</thead>
<tbody>
<tr>
<td>No.</td>
<td>19</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>6 (32)</td>
<td>5 (31)</td>
<td>0.983</td>
</tr>
<tr>
<td>Age years</td>
<td>54 ± 8.9</td>
<td>54 ± 12.8</td>
<td>0.960</td>
</tr>
<tr>
<td>Pain duration years</td>
<td>8.6 ± 6.6</td>
<td>32.9 ± 13.7</td>
<td>0.230</td>
</tr>
<tr>
<td>NRS pain</td>
<td>6.3 ± 13</td>
<td>71 ± 12</td>
<td>0.086</td>
</tr>
<tr>
<td>ODI 2.0</td>
<td>43.2 ± 14.2</td>
<td>39.8 ± 15.4</td>
<td>0.477</td>
</tr>
<tr>
<td>BMI</td>
<td>30.8 ± 8.7</td>
<td>29.1 ± 5.2</td>
<td>0.509</td>
</tr>
<tr>
<td>Narcotic Intake</td>
<td>10 (51)</td>
<td>8 (50)</td>
<td>0.877</td>
</tr>
<tr>
<td>SSRI/SSNRI</td>
<td>2 (1)</td>
<td>1 (6)</td>
<td>0.566</td>
</tr>
<tr>
<td>Gabapentin/pregabalin</td>
<td>3 (16)</td>
<td>2 (13)</td>
<td>0.585</td>
</tr>
<tr>
<td>Epidural Steroid</td>
<td>3 (16)</td>
<td>4 (25)</td>
<td>0.398</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>----------</td>
<td>--------</td>
<td>----------</td>
</tr>
<tr>
<td>Diagnostic Categories</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lumbar spinal stenosis</td>
<td>8 (42)</td>
<td>3 (39)</td>
<td></td>
</tr>
<tr>
<td>Lumbar radiculopathy</td>
<td>6 (32)</td>
<td>3 (39)</td>
<td></td>
</tr>
<tr>
<td>Peripheral neuropathy</td>
<td>0</td>
<td>2 (12)</td>
<td>0.195</td>
</tr>
<tr>
<td>Post Laminectomy</td>
<td>2 (10)</td>
<td>2 (12)</td>
<td></td>
</tr>
<tr>
<td>Nonspecific low back pain</td>
<td>3 (16)</td>
<td>6 (38)</td>
<td></td>
</tr>
</tbody>
</table>

aValues are expressed as No. (%) or mean ± SD.
bP values obtained from ANOVA for numeric variables. For non-numeric variables the Pearson chi square results were utilized except when cell counts were less than 5, in which case the Fisher’s exact test results were used.

Between-group comparisons of NRS score change between baseline and follow-up time points favored the intervention group at all points except 2 weeks: 15 minutes (4.4 ± 1.7 vs 2.4 ± 2.8 points; P = 0.015), 2 hours (4.6 ± 1.9 vs 1.8 ±
Figure 1. Diagnostic Category Assignment Method

- Pain imitated progressively with standing and relieved by sitting + one of the following:
  - MRI findings of mod. to severe central stenosis any lumbar level
  - MRI findings of mod. central stenosis any lumbar level + EMG findings of multilevel chronic radiculopathy.
  - MRI findings of severe lumbar lateral recess stenosis any level that correlates with symptoms.

  → Y → Lumbar Spinal Stenosis

  N

- One of the following:
  - Pain imitated with nerve tension signs
  - Radicular pattern of weakness or sensory loss
  - EMG/MRI findings consistent with dermatomal pattern.

  → Y → Lumbar Radiculopathy

  N

- EMG indicative of peripheral neuropathy in area of pain

  → Y → Peripheral Neuropathy

  N

- History of back surgery without benefit

  → Y → Failed Back Surgery

  N → Nonspecific Low Back Pain

Pseudoclaudication plus moderate to severe radiographic findings were required for spinal stenosis assignment, hard neurologic examination or electromyographic findings for radiculopathy assignment, and electromyographic findings for peripheral neuropathy categorization.

2.8 points; \( P = 0.001 \), 4 hours (4.6 ± 2.0 vs 1.4 ± 2.3 points; \( P < 0.001 \)), 48 hours (3.0 ± 2.3 vs 1.0 ± 2.1 points; \( P = 0.012 \)), and 2 weeks (2.1 ± 2.9 vs 1.2 ± 2.4 points; \( P = 0.217 \)), (Table 2, Figure 3). The number of participants achieving \( \geq 50\% \) improvement in pain at 4 hours was higher in dextrose recipients (16/19; 84%) than in saline recipients (3/16; 19%; \( P < 0.001 \)). Variables analyzed as covariates, including diagnostic category, were not predictive of point change in either group.

5. Discussion

This RCT found that, among participants with CLBP and either buttock or leg pain, 10 mL of dextrose injected in the caudal epidural space, compared with injection of 10 mL of normal saline, resulted in substantial, consistent, and significant analgesia within 15 minutes that lasted at least 48 hours. Pain improvement in the dextrose group at 15 minutes, 2 and 4 hours exceeded twice the minimal important change for pain improvement in low back pain as measured by NRS for pain (24). These results suggest a short-term analgesic effect of dextrose for CLBP with radiation to buttock or leg. Dextrose appears safe; 5% - 10% dextrose has been used to alter the spread of epidural anesthesia (11-14, 25-31) and has not been associated with complications. The current study was not powered to detect rare complications or adverse events. Previous studies including dextrose in the injectate did not assess for an analgesic effect attributable specifically to dextrose. These findings suggest for the first time that 5% dextrose injected in the caudal space may confer a pain-specific neurogenic effect at the dorsal root level. The selection of 10 mL volume as the dose of 5% dextrose was based on the authors’ clinical experience. It is unclear if this is optimal for all patients, as the dermatomal pain level for each patient is not the same. Given an analgesic effect in participants with pain at and above the iliac crest level, which is supplied by T12-L1, this suggests that the 10 mL volume introduced vertically at the sacral cornua level (20) was sufficient to allow cephalad flow of dextrose. Injection of larger volumes of 5% dex-
Met criteria at initial outpatient presentation and offered participation (n = 56)

Declined (n = 19)

Randomized (n = 37)

Allocated to 10 ml caudal D5W (n = 19)

Allocated to 10 ml caudal NS (n = 18)

Intolerant of injection due to painful cramping. Withdrawn from study (n = 2)

Received intervention (n = 19)

Received intervention (n = 16)

Analyzed (n = 19)

Analyzed (n = 16)

Figure 2. Consort Flow Diagram

Figure 3. Change in 0-10 NRS Pain Scores Over 2 Weeks (± Standard Error)

NRS is scored on a range of 0 to 10 points, with 10 anchored by “worst pain imaginable” and 0 by “no pain”. Non-overlapping confidence intervals indicate significance of change in dextrose scores compared with change in score of the saline (P < 0.05) group.

This is the first study to assess the analgesic effect of dextrose injected in the caudal epidural space. Onset of analgesia compares well with reported onset with epidural morphine and fentanyl and may be of longer duration (32, 33). It did not alter sensation, although the analgesia was longer than that reported for single epidural injection of bupivacaine in one study (34).

These data are consistent with the effects of dextrose in two other contexts: First, hypertonic dextrose has been used for decades in prolotherapy, a technique that addresses pain receptors at entheses and intra-articular structures (8). Decreased pain and improved function after dextrose injection is reported in RCTs for several chronic conditions including rotator cuff tendinopathy (35), knee osteoarthritis (9, 36-38), Osgood Schlatter disease (39), hand osteoarthritis (40, 41), lateral epicondylosis (42, 43), and SI joint dysfunction (44). While dextrose injection has not been associated with changes in connective tissue assessed radiographically (35, 43), a recent open label study reports an association between intra-articular dextrose for knee osteoarthritis and histologically-assessed chondroge-
Table 2. Change in the NRS for Pain Severity From Baseline to 2 Weeks After Injection of 10 mL of Either 5% Dextrose or Normal Saline Into the Caudal Epidural Space

<table>
<thead>
<tr>
<th>Raw score and Change Score</th>
<th>Dextrose [n = 19]</th>
<th>Saline [n = 16]</th>
<th>Significance: P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Baseline: Raw score</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>6.3 ± 1.3</td>
<td>7.1 ± 1.2</td>
<td>NA</td>
</tr>
<tr>
<td><strong>Change in score</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>NA</td>
<td>NA</td>
<td></td>
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<tr>
<td><strong>15 minutes: Raw score</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.0 ± 1.6</td>
<td>4.7 ± 3.2</td>
<td>0.015</td>
</tr>
<tr>
<td><strong>Change in score</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4.4 ± 1.7</td>
<td>2.4 ± 2.8</td>
<td></td>
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<tr>
<td><strong>2 hours: Raw score</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.7 ± 1.5</td>
<td>5.3 ± 3.0</td>
<td>0.001</td>
</tr>
<tr>
<td><strong>Change in score</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4.6 ± 1.9</td>
<td>1.8 ± 2.8</td>
<td></td>
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<tr>
<td><strong>4 hours: Raw score</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>1.7 ± 1.6</td>
<td>5.6 ± 2.7</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td><strong>Change in score</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4.6 ± 2.0</td>
<td>1.5 ± 2.3</td>
<td></td>
</tr>
<tr>
<td><strong>48 hours: Raw score</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.3 ± 1.9</td>
<td>6.4 ± 2.6</td>
<td>0.012</td>
</tr>
<tr>
<td><strong>Change in score</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.0 ± 2.3</td>
<td>1.0 ± 2.1</td>
<td></td>
</tr>
<tr>
<td><strong>2 weeks: Raw score</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4.2 ± 1.4</td>
<td>5.9 ± 2.6</td>
<td>0.217</td>
</tr>
<tr>
<td><strong>Change in score</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.1 ± 1.2</td>
<td>1.2 ± 2.4</td>
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</tr>
</tbody>
</table>

*Values are expressed as mean ± SD.

*Significance of the mean difference for change between groups.

Researchers have hypothesized that dextrose may reduce pain directly through a sensorineural mechanism. Afferent fibers expressing the transient receptor potential vanilloid receptor-1 (TRPV-1) cation channel, formerly known as the capsaicin-sensitive receptor, are widely accepted as the fibers on which much neuropathic pain depends (46, 47). Although long-term exposure to dextrose (in culture medium) may increase mRNA for TRPV-1 and predispose to neurogenic dysfunction (48), single dextrose injection may have a different effect on sensory nerves expressing the TRPV-1 cation channel. Mannitol, a molecule structurally chemically similar to dextrose, has been found to reduce capsaicin-induced burning pain upon application to the lip (49). Superficial dextrose injections targeting sensory nerves have been reported in a clinical trial to decrease trigger point-related pain more than lidocaine injections (50). Participants with Achilles tendinopathy in another study who received both exercise and dextrose injections targeting superficial sensory nerves report more improvement compared to exercise alone (19).

Limitations of this study include its short duration; however, the data support our hypothesis that dextrose reduces pain compared to control injection in the short term. In addition, this study cannot determine if the analgesic effect reported by dextrose participants is a one-time response, nor whether pain reduction can be repeated or endure with additional injections. We did not assess self-reported or objectively assessed function and so cannot comment on functional improvement, a key factor in treatment of CLBP. In addition, while participants did not report unexpected side effects or adverse events, the study is not powered to detect rare events, nor events occurring in the long term. Results from a long-term study of the effects of serial dextrose injection on pain and functional abilities and monitoring for safety concerns will be separately reported. The small sample size and varied diagnostic criteria limit our ability to comment directly on the clinical effect of dextrose for any specific baseline CLBP diagnosis. However, the analgesic effect seen across various diagnostic categories suggests a potential common mechanism of neurogenic pain. The precise dosage of analgesic medication taken before and during the two week period of the study was not monitored, so we cannot comment on the short-term effect of caudal epidural injection of DSW versus saline on analgesic intake. However, given that participants were stable regarding morphine equivalent dosing prior to the study, the immediate analgesic effect indicated herein appears to be independent of narcotic medication intake. Blinding was not assessed, possibly introducing bias; however, the randomization was effective and dextrose and saline are both colorless, transparent and of similar viscosity.

5.1. Conclusions

Compared with blinded saline, dextrose caudal epidural injection resulted in substantial analgesia within 15 minutes that persisted for 48 hours among chronic nonsurgical LBP patients with buttock and/or leg pain, suggesting a neurogenic effect of dextrose in the caudal space. Basic science and clinical studies of longer duration and measuring both pain and functional outcomes are needed to elucidate the mechanism of action and potential clinical application of caudal epidural dextrose injection.
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Footnote

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References


