Modification of Electroconvulsive Therapy Induced Hypertension with Nitroglycerin Ointment

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Significant transient hypertension and tachycardia occur during electroconvulsive therapy (ECT). Patients who are already hypertensive may have exaggerated cardiovascular responses.1,2 Nitroglycerin ointment, with its venodilator effect, may prevent excessive hypertension and increased myocardial oxygen demand during ECT. We therefore designed this study to determine whether nitroglycerin ointment will attenuate the adverse cardiovascular response normally accompanying ECT during anesthesia.

METHODS

This study was approved by our institutional Human Research Committee. Seven consecutive ASA Class I and II patients who underwent ECT gave their informed consent to participate in the study. Each patient received two sessions of multiple-monitored ECT (MMECT) separated by 2–3 days. Each session of MMECT consisted of three to four consecutive ECTs separated by a 5–10 min recovery time under anesthesia (about 60 min in duration). Pulse frequency, pulse width, and stimulus duration were selected by the attending psychiatrist (R.S.) and remained similar in both sessions. There were no changes in the patients’ medication throughout the study (all seven patients received tricyclic antidepressants. In addition, three had benzodiazepam, two had lithium, two had phenothiazine, and two had digoxin and beta blocker). One session was preceded by application of 2½ inches of 2% nitroglycerin ointment 45 min before beginning the ECT. The other session was done without nitroglycerin ointment. Thus, each patient served as his or her own control. The treatment sequence was done in random order. All patients were premedicated with promethazine (Phenergan®) 50 mg and glycopyrrolate (Robinul®) 0.004 mg/kg intramuscularly 45 min prior to ECT. After the patient arrived in the operating room, a radial artery catheter was inserted and ECG electrodes were applied. Induction of anesthesia was accomplished with a single dose of methohexital (2–3 mg/kg) followed by succinylcholine infusion to facilitate endotracheal intubation. All tracheas were intubated and ventilation controlled with an FiO2 of 1.0. Succinylcholine was continued to prevent the peripheral effects of convulsions, the dose being adjusted by use of a nerve stimulator. Radial artery blood pressure, heart rate, and seizure duration (with EEG) were recorded. Following intubation and each ECT, arterial blood pressure and heart rate were allowed to stabilize for 5–10 min or until returning to the initial level.

After the completion of the last ECT, succinylcholine was discontinued. When spontaneous respiration resumed, the trachea was extubated while the patient was still in the operating room. They were then transported to the recovery area (PAR). The nursing staff recorded each patient’s arterial blood pressure, heart rate, and PAR recovery scores5 on admission and discharge from the recovery room. Nitroglycerin ointment was removed prior to leaving the recovery room.

Data were analyzed by paired t test. The level of significance used was P < 0.05.

RESULTS

A total of 54 ECTs were performed in 14 sessions, 27 with and 27 without nitroglycerin ointment. For all treatments combined, mean systolic blood pressure increased 41 ± 22 mmHg (mean ± SD) in control patients (table 1). In the same patients receiving nitroglycerin ointment, mean systolic arterial blood pressure increased 17 ± 16 mmHg (P < 0.005). Increases in systolic blood pressure for each ECT were significantly smaller when nitroglycerin ointment was used (P < 0.05 for each ECT) (fig. 1).
### TABLE 1. Effects of Multiple-monitored ECT

|                      | Systolic BP Increase (mmHg) | Heart Rate Increase (min. 
<table>
<thead>
<tr>
<th></th>
<th>(mmHg)</th>
<th>)</th>
<th>Rate-Press Prod. Increase</th>
<th>PAR Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Without nitroglycerin ointment</td>
<td>41 ± 22</td>
<td>28 ± 26</td>
<td>9,330 ± 6,818</td>
<td>7.0 ± 1.5</td>
</tr>
<tr>
<td>With nitroglycerin ointment</td>
<td>17 ± 16</td>
<td>16 ± 15</td>
<td>4,094 ± 3,276</td>
<td>7.0 ± 2.0</td>
</tr>
</tbody>
</table>

*NS* = non significant.

When nitroglycerin ointment was used, mean increases in heart rate following ECT for all treatments combined were smaller (28 ± 26/min without vs. 16 ± 15/min with) (*P* < 0.01). There were no significant differences in heart rate changes in three out of four ECTs. Heart rate increases were significantly higher in the untreated group during the fourth ECT (fig. 2).

Rate–pressure product changes (post-ECT–pre-ECT) were significantly less following nitroglycerin ointment (9,330 ± 6,818 without vs. 4,094 ± 3,276 with) (*P* < 0.005).

Comparison of PAR recovery scores on admission showed no significant difference between the control patients and the patients receiving nitroglycerin ointment. Followup visits performed at 24 h post-ECT by the author (J.L.) revealed no complaints of headache or other untoward side effects (hypotension or tachycardia).

### DISCUSSION

Electroconvulsive therapy is used to treat major affective disorders. In our institution, ECT is performed in the operating room using general anesthesia. The cardiovascular effects of ECT are well known. Transient bradycardia that appears immediately after onset of the electrically induced seizure is attributed to sudden increase of cardiac parasympathetic outflow. Other rhythm disturbances are also common with ECT. Pitts et al. reported an 8–41% incidence of ventricular dysrhythmias, depending on the barbiturate used and upon the presence or absence of cardiac disease.

The hypertension and tachycardia are of rapid onset, in our experience, peaking within 30 s. This may be due to direct effect of sympathetic nervous outflow or may be in part due to a rise in catecholamine levels from adrenal medullary secretion. Anton et al. measured markedly elevated (10–50 fold) plasma norepinephrine and epinephrine concentrations within 1 min of onset of seizure in dogs.

The hypertension and tachycardia resulting from ECT may cause potentially serious adverse reactions such as myocardial infarction or stroke. Cardiac arrest appears to be a leading cause of death associated with

![Graph showing systolic blood pressure change](http://anesthesiology.pubs.asahq.org/pdfaccess.ashx?url=/data/journals/jasa/931410/)
the administration of ECT.\textsuperscript{1} Patients who have coronary
d artery disease are at greater risk.\textsuperscript{6} Patients who are
hypertensive are likely to have exaggerated responses
and thus are predisposed to these complications.\textsuperscript{7} In a
series of 350 patients who underwent multiple monitored
ECT, Malcetzyk noted that 92 patients (26\%) had significant
cardiovascular or pulmonary disease. Of these 92
patients, 54 patients had concomitant hypertension (ave-
erage age 56.4 years).\textsuperscript{8} Because patients usually receive
several ECTs, there exists a need to reduce the excessive
cardiovascular responses.

Barbiturates and many types of antihypertensive agents
have been used to modify the cardiovascular response
to ECT.\textsuperscript{2,5,8,10,11} Results have been unsatisfactory due
to prolonged and severe hypotension, asystole, or pre-
vvention of the seizure itself. Use of potent vasodilators
or ganglionic blockers is more difficult because of the
transient nature of the cardiovascular responses and the
need for invasive monitoring for their safe administra-
tion. To attenuate the ECT-induced hypertension effec-
tively with a drug that is relatively safe and easy to
administer, we therefore chose nitroglycerin ointment
for further study. Nitroglycerin ointment, a lanolin-
petroleum-based ointment, produces primarily veno-
dilation and results in peripheral pooling of blood. Nitro-
glycerin also causes direct coronary vasodilation.
With topical application, reduction of systolic arterial blood
pressure begins within 15 min and reaches a maximum
in about 2 h. The increase in heart rate (which usually
is small) is maximal in 60 min. Left ventricular end-
diastolic dimension, a measurement of preload, reaches
its lowest level in 60 min.\textsuperscript{12}

Our results suggest that nitroglycerin ointment as a
premedication (2\% preparation, 2\% inches, 45 min
before the beginning of the ECT) significantly attenuates
ECT-induced hypertension. In addition, we found no
significant increase in heart rate resulting from the use
of nitroglycerin ointment when compared with the
control group. We believe that the minimal reflex
increase of heart rate associated with nitroglycerin oint-
ment was masked by the presence of tachycardia resulting
from ECT alone.

In our follow-up visits, no side effects of nitroglycerin
ointment (e.g., headache, orthostatic hypotension, tachy-
cardia, faintness, or flushing) were found. Patients re-
covered from the procedures well; the mean recovery
times of the two groups were identical.

We conclude that arterial blood pressure and heart
rate increases during ECT can be attenuated effectively
by application of nitroglycerin ointment. This may be
especially beneficial for patients who are at increased
risk of myocardial ischemia and stroke.

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\textbf{REFERENCES}

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Efficacy of Oral Nifedipine in the Treatment of Reflex Sympathetic Dystrophy

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Reflex sympathetic dystrophy (RSD), is a common posttraumatic pain syndrome for which no reliably effective oral form of therapy has been found. Oral therapy has been attempted with steroids, tricyclic antidepressants, beta-blockers, and antiseizure medications, none of which are predictably helpful.1-5 Multiple invasive treatments, including sympathetic blockade and iv regional local anesthetic, reserpine, or guanethidin blocks, have been employed, but again with inconsistent success.6-9 Transcutaneous nerve stimulation is effective in some patients10 but aggravates symptoms in others.11

Following a report of the use of oral nifedipine in the treatment of Raynaud's phenomenon,12 a syndrome that, like RSD, is characterized by vasoconstriction and cold intolerance, we studied the ability of orally administered nifedipine to relieve the symptoms of RSD.

METHODS

Thirteen patients were treated with nifedipine in an open-label study after they had given informed consent for a protocol approved by our institutional review board. The ages of the 10 female and three male patients ranged from 11 to 66 years (average—39 years). The patients first were interviewed by one of the study participants (D.S.P. or C.H.M.) when they had been referred with a probable diagnosis of RSD. Criteria for entry into the study included a clear history of trauma with the subsequent onset of pain characterized by one or more of the following: burning character, dysesthesias, cold intolerance, and trophic changes. A cold stress test13 was performed on most patients but was not a criterion for entry into the study. Nifedipine was

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