Dysrhythmias Following Muscle Relaxant Administration in Patients Receiving Digitalis

ROBERT S. BARTOLONE, D.O.,* AND TADIKONDA L. K. RAO, M.D.†

Succinylcholine can cause significantly increased incidence dysrhythmias in patients taking digitalis.1 To prevent these dysrhythmias, administration of nondepolarizing relaxants has been advocated in these patients.1 When rapid sequence induction of anesthesia and endotracheal intubation is planned, large doses of nondepolarizing muscle relaxants are administered rapidly to achieve paralysis quickly. However, such large doses of nondepolarizing muscle relaxants can be associated with either hypotension or hypertension and tachycardia.2,3 Whether these large doses of nondepolarizing muscle relaxants may cause significant cardiovascular changes in patients receiving digitalis is not known. We therefore sought to compare the incidence and severity of dysrhythmias following the iv administration of succinylcholine or pancuronium in patients chronically receiving digitalis.

MATERIALS AND METHODS

This investigation included 104 patients and was approved by the Institutional Review Board, and the patients' consent was obtained prior to the study. Ages of the patients ranged from 18 to 61 years with a mean age of 46.3 ± 17.4 (SEM) years. Groups 1 (N = 20) and 2 (N = 20) consisted of ASA physical status I patients who were not receiving digitalis or diuretic therapy. Groups 3 (N = 46) and 4 (N = 18) consisted of ASA physical status II patients who were receiving digoxin, diuretic, and potassium supplementation therapy for at least six months prior to anesthesia and surgery. Patients with normal sinus rhythm only were included in the investigation. Patients in Groups 3 and 4 received their morning dose of digitalis prior to surgery.

Premedication included 6 μg/kg atropine and 15 μg/kg morphine which was administered im, one hour prior to the anticipated time of surgery. In the operating room, lead II ECG was monitored continuously and recorded prior to and up to 15 min following the administration of the muscle relaxant. Blood pressure was recorded every 2 min from the time of induction of anesthesia until the completion of the study. Prior to induction of anesthesia, which coincided with 4- to 6-hr periods following the oral administration of digitalis, 5 ml of venous blood were withdrawn for the measurement of plasma digoxin values in Groups 3 and 4 and plasma potassium values in all four groups. Plasma concentration of digoxin was determined in duplicate by radioimmunoassay using a commercial 125I kit. Anesthesia was induced with 4 mg/kg thiopental. Patients in Groups 1 and 3 received 2.0 mg/kg succinylcholine, iv, over a period of 30 s, while patients in Groups 2 and 4 received 0.12 mg/kg pancuronium, iv, over a period of 1 min. All patients were ventilated via mask with 50% nitrous oxide and oxygen for three min following which venous blood samples were withdrawn for the measurement of serum potassium and arterial samples were analyzed to assure adequate ventilation. ECG recording of each patient was analyzed later for the incidence and types of dysrhythmia if present. Statistical analysis was performed using chi-square, Student's t test for paired and nonpaired values. All values are expressed as means ± SEM, P values of less than 0.05 were considered significant.

RESULTS

Patients' age and preinduction serum potassium values were comparable and within normal limits in all the four groups (table 1). In Group 1, following succinylcholine administration, serum potassium significantly increased from 4.12 ± 0.14 mEq/l to 5.2 ± 0.21 mEq/l (P < 0.01). Similarly, in Group 3, serum potassium significantly increased from 4.21 ± 0.1 mEq/l to 5.16 ± 0.18 mEq/l (P < 0.05) following succinylcholine administration. Changes in serum potassium values in Groups 2 and 4 were not significant. Three minutes following induction of anesthesia and manual ventilation, Pco2 was 34.4 ± 2.7 mmHg.

The preinduction serum digoxin value in Group 3 was 1.84 ± 0.14 ng/ml and 1.91 ± 0.11 ng/ml in Group 4 and were not statistically different. None of the patients manifested any dysrhythmias following induction of anesthesia but prior to the administration of the muscle relaxants. In Group 1 patients who were not taking digitalis and received succinylcholine, dysrhythmias oc-
Table 1. Patients' Age, Potassium, Digoxin, and $P_{a}CO_2$ Values and Incidence of Dysrhythmias

<table>
<thead>
<tr>
<th></th>
<th>Group 1</th>
<th>Group 2</th>
<th>Group 3</th>
<th>Group 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Patients</td>
<td>20</td>
<td>20</td>
<td>46</td>
<td>18</td>
</tr>
<tr>
<td>Age (yr)</td>
<td>28 ± 2.4</td>
<td>31 ± 3.1</td>
<td>56 ± 3.4</td>
<td>52 ± 4.1</td>
</tr>
<tr>
<td>Serum K(^+) values prior to muscle relaxant administration (mEq/l)</td>
<td>4.12 ± 0.14</td>
<td>4.22 ± 0.12</td>
<td>4.21 ± 0.1</td>
<td>4.17 ± 0.11</td>
</tr>
<tr>
<td>Serum K(^+) values 3 min following muscle relaxant administration (mEq/l)</td>
<td>5.2 ± 0.21</td>
<td>4.1 ± 0.1</td>
<td>5.16 ± 0.18</td>
<td>4.04 ± 0.12</td>
</tr>
<tr>
<td>Serum digoxin values (mg/ml)</td>
<td>—</td>
<td>—</td>
<td>1.84 ± 0.14</td>
<td>1.9 ± 0.11</td>
</tr>
<tr>
<td>$P_{a}CO_2$ after induction (mmHg)</td>
<td>36 ± 2.4</td>
<td>35 ± 2.1</td>
<td>34 ± 2.3</td>
<td>34 ± 2.6</td>
</tr>
<tr>
<td>Incidence of dysrhythmias</td>
<td>3</td>
<td>5</td>
<td>5</td>
<td>6*</td>
</tr>
</tbody>
</table>

* $P < 0.01$ compared with Group 3.

occurred in three patients (3/20). These included bradycardia of less than 40 beats/min in two patients to whom atropine was administered and one patient who developed nodal rhythm which persisted for four minutes and then returned to sinus rhythm. In patients in Group 2 who were not taking digitalis and received pancuronium, sinus tachycardia with heart rates of 150 beats/min occurred in five patients (5/20). In patients in Group 3 who were taking digitalis and received succinylcholine, two of them developed dysrhythmias that included bradycardia of less than 40 beats/min and premature ventricular contractions greater than 15/ min that reverted to sinus rhythm in one minute without any antiarrhythmic therapy (3/46). In patients in Group 4 who were taking digitalis and received pancuronium, six developed dysrhythmias. These included sinus tachycardia of 150 beats/min in four patients and atrial flutter in two patients (6/18). The incidence of dysrhythmias was statistically significant only between Groups 3 and 4 ($P < 0.01$).

In all four groups, arterial blood pressure did not decrease significantly following induction of anesthesia or the changes in the pressure were not significantly different between the four groups.

**DISCUSSION**

Most of the clinically available muscle relaxants have been shown to cause cardiovascular effects. Succinylcholine produces dysrhythmias both in patients who have and have not been taking digitalis. Dowdy and Fabian reported dysrhythmias following the administration of succinylcholine in patients taking digitalis.\(^1\)

Of the 17 patients in that study, eight (47%) developed various dysrhythmias that included bigeminy, frequent multifocal premature ventricular contractions, ventricular tachycardia, and ventricular fibrillation. However, the serum digitalis levels, arterial blood gases, and electrolyte statuses of these patients were not measured. Following succinylcholine administration, Perez\(^4\) reported a 76% incidence of dysrhythmias in cardiac patients taking digitalis; however, endotracheal intubation was performed immediately following succinylcholine administration which may have contributed to these dysrhythmias.

In our study, serum electrolytes were measured both prior to and following the administration of muscle relaxants. Patients in Groups 3 and 4 had their serum digitalis values measured prior to the administration of succinylcholine and were found to be in the normal clinical range. Normal serum digoxin values along with the preoperative ECG and clinical assessment probably excluded the possibility of under- or over-digitalization. Adequate ventilation during the study period of three minutes was confirmed by analysis of arterial blood gases. Airway was not manipulated during this 3-min period thereby avoiding dysrhythmias from airway stimulation. Thus, the dysrhythmias that occurred in our patients were solely due to the muscle relaxants administered. We found no significant difference in the incidence of dysrhythmias following succinylcholine administration in Groups 1 and 3 or following pancuronium administration in Groups 2 and 4. However, when Groups 3 and 4 were compared, the incidence of dysrhythmias was significantly higher in Group 4 patients who were taking digitalis and received pancuronium ($P < 0.01$).

Following the administration of pancuronium in the first 16 patients who were receiving digitalis, one in three patients developed dysrhythmias. This resulted in our ethically deciding not to administer pancuronium in patients receiving digitalis which contributed to a smaller N in group four.

In a study of 96 patients scheduled for elective surgery, List\(^5\) showed a 15.2% incidence of dysrhythmias with first dose succinylcholine. This correlated well with our study in which there was a 15% (3/20) incidence of dysrhythmias in the control group. A significant increase in serum K\(^+\) values occurred in both Groups 1 and 3 following succinylcholine administration. However, List\(^5\) and Evers \textit{et al.}\(^6\) were unable to show a simple temporal relationship between increases in K\(^+\) and ECG changes after succinylcholine.

Both exogenous or endogenous catecholamines can
cause cardiac dysrhythmias, especially in digitalized patients receiving digitalis. Pancuronium has a vagolytic effect,\textsuperscript{2,3} a direct sympathomimetic effect,\textsuperscript{9} an indirect sympathomimetic effect by increased release of norepinephrine,\textsuperscript{10} and by preventing re-uptake of norepinephrine\textsuperscript{11–13} results in increased circulating catecholamine levels.\textsuperscript{14} This may be the cause for increased incidence of dysrhythmias following pancuronium administration in our group of patients who were receiving digitalis.

In this clinical investigation, the doses of muscle relaxants used are much smaller than one would use during rapid sequence induction. Added to this, during rapid sequence induction, the patients are not ventilated for about 45 s to 1 min during which time mild hypercarbia occurs. Thus, if these relaxants are used in rapid sequence induction in patients receiving digitalis, the effects on cardiovascular system might be more profound than those reported here.

In conclusion, we found that succinylcholine is associated with a lower incidence of dysrhythmias than pancuronium in patients receiving digitalis. Thus, caution should be exercised in administering pancuronium to such patients. Succinylcholine need not be withheld in patients receiving digitalis requiring the relaxant for rapid sequence endotracheal intubation.

REFERENCES


Acute Pulmonary Embolism during Therapeutic Arterial Embolization with Silicone Fluids

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Arterial embolization with gelfoam, silicone spheres, polyvinyl alcohol foam (PVA), isobutyl-2-cyanoacrylate (IBCA), or silicon fluid mixtures, has been used clinically to terminate the blood supply of arteriovenous malformations (AVM).\textsuperscript{1–6} Serious pulmonary embolization with this method usually does not occur\textsuperscript{1,7} because most of the embolizing substance is trapped within the malformation leaving only a small quantity to reach the pulmonary circulation.\textsuperscript{1,8} However, we describe a patient who developed severe pulmonary embolism with silicone liquid during this procedure.

REPORT OF A CASE

A 27-year-old woman was admitted for embolization of an arteriovenous malformation (AVM) of the right thigh. She first noted discoloration over the right calf 13 years ago. This gradually increased in size leading to ulceration and recurrent bleeding. Angiography at that time demonstrated an extensive AVM of the right leg. Two un-