A comparison study of vecuronium bromide and atracurium besylate for rapid sequence induction

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Rapid sequence induction is necessary in emergency surgical operations to lessen the chance of aspiration of stomach contents. Succinylcholine usually is the relaxant of choice, because of its rapid onset. However, succinylcholine has side effects which may result in potentially life-threatening conditions.

The purpose of this study was to compare two short-acting non-depolarizing muscle relaxants — vecuronium and atracurium, using the priming principle, with a depolarizing muscle relaxant, succinylcholine. The comparison may determine if a more suitable method for rapid sequence induction can be identified.

Conditions at intubation and at the time to 80-90% neuromuscular blockade were evaluated. Subjects were intubated when the train of four revealed an 80-90% twitch depression. In Group I, the control group using succinylcholine, the mean time to 80-90% neuromuscular block was 74.8 seconds. In Group II subjects, who had received vecuronium, the mean time was 149.4 seconds. Subjects in Group III, who received atracurium, had a mean time of 163.7 seconds.

There was statistical significance within all three groups (ANOVA, p<0.01). Group I subjects showed a significantly faster time to 80-90% neuromuscular block when compared with subjects in Group II and III, but no difference in the time to 80-90% block was revealed between Group II and Group III subjects. Conditions for intubation at 80-90% neuromuscular blockade were the same for all three groups. It was concluded that the administration of vecuronium and atracurium using the priming principle did not allow onset times similar to succinylcholine and that the intubating conditions were similar among all three groups at 80-90% neuromuscular blockade.

Rapid sequence induction is necessary in emergency surgery to lessen the likelihood of aspiration of gastric contents. As early as 1883, aspiration was named as the cause of an anesthetic death.\(^1\)

Succinylcholine produces acceptable conditions for intubation in 60 to 90 seconds and usually is the relaxant of choice. Unfortunately, succinylcholine has side effects which can result in potentially life-threatening conditions. Therefore, the use of an alternative muscle relaxant with a rapid onset and a lack of serious side effects would be a great advantage in a rapid sequence induction.
The value of vecuronium bromide and atracurium besylate as substitute agents for succinylcholine would be enhanced greatly if they had shorter onset times. The priming principle may be an alternative method for accomplishing this.²

This study was intended to compare succinylcholine, vecuronium and atracurium for rapid sequence induction. Using succinylcholine as the control, the study compared onset time and intubating conditions with those of vecuronium and atracurium. The priming principle was implemented for vecuronium and atracurium.

Methodology

Thirty patients who met established criteria were accepted into this randomized study. Approval was received from the institutional human subjects committee, and informed consent was obtained.

Criteria for admission to the study included patients undergoing non-cardiac, non-neurological and non-obstetrical surgery. All of the patients were classified ASA I or II and were between the ages of 18 and 75. All were without a history of neuromuscular disease or disorder and had no history of drug abuse or addiction. None of the patients received a preoperative medication.

The subjects were assigned randomly to three groups of ten. Group I served as the control group and received succinylcholine for intubation. The dosages employed were 3 mg of d-Tubocurarine as a pretreatment, followed by 2 mg/kg of succinylcholine. Group II subjects received vecuronium for intubation, with a priming dose of 0.01 mg/kg, followed by 0.1 mg/kg. Group III subjects received atracurium for intubation, with a priming dose of 0.05 mg/kg, followed by 0.5 mg/kg.

Upon arrival in the operating room, each patient was made comfortable, and his or her vital signs were monitored with an electrocardiogram, a blood pressure cuff, a precordial stethoscope and a temperature monitoring device. In addition, the Bard critical care peripheral nerve stimulator dual-element foam electrode pad was placed over the ulnar nerve near the wrist, and a Neurostim™ peripheral nerve stimulator was used to monitor neuromuscular blockade.

Prior to the induction of anesthesia, 100% oxygen was administered for 5 minutes via face mask and 50-100 μg fentanyl was administered. One minute following the fentanyl, the d-Tubocurarine or the priming dose of the muscle relaxant was given intravenously. Three minutes later, anesthesia was induced with sodium thiopentone 4-5 mg/kg, followed by lidocaine 100 mg and then immediately by succinylcholine or the second dose of the non-depolarizing muscle relaxant.

A control train of four was noted after the administration of sodium thiopentone and then observed every 10 seconds after the muscle relaxant was administered for depression, assimilating 80-90% neuromuscular blockade. Eighty to ninety percent neuromuscular blockade was determined to be present when one twitch in the train of four remained. At this point, the time was noted and intubation attempted. The same investigator determined the time of 80-90% neuromuscular block in all patients.

At the time of laryngoscopy, intubated conditions were categorized as follows:

- Excellent—jaw relaxed, vocal cords apart and immobile with no diaphragmatic movement.
- Good—jaw relaxed, vocal cords apart and immobile and some diaphragmatic movement.
- Poor—jaw relaxed, vocal cords moving and bucking present.
- Inadequate—jaw poorly relaxed, vocal cords moving and coughing present.
- Not possible to intubate.

Intubation was attempted and categorized by one of four anesthesia providers, all of whom were proficient in intubation skills. After successful intubation and judgment of the intubating conditions, the study aspect of the anesthetic was concluded.

Data analysis

Because three different groups were being compared using several measures over time and ordinal data for conditions at intubation, two-factor analysis of variance (ANOVA) was used to identify the overall differences among the groups and within the groups.

Results

Ranges and means of ages and weights of the three groups are listed in Table I. The groups were similar with respect to age and weight, and there were no differences in time to 80-90% neuromuscular block or conditions of intubation with respect to the ages and weights among the groups.

| Table I |
|---|---|---|
| Ranges and means of ages and weights of subjects |
| Age | Age | Weight |
| Range | Mean | kg |
| Group I | 25-75 | 50.1 | 54-100 | 74.5 |
| Group II | 18-71 | 47.4 | 55-98 | 70.1 |
| Group III | 27-72 | 53.6 | 45-88 | 70.8 |

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The times to 80-90% twitch depression for all three groups are listed in Table II. In Group I, the control group on which succinylcholine was used, the mean time to 80-90% neuromuscular block was 74.8 seconds. In Group II, the vecuronium group, the mean time for 80-90% twitch depression was 149.4 seconds. In Group III, the atracurium group, 163.7 seconds was the mean time to 80-90% neuromuscular blockade.

There was statistical significance within all three groups, (ANOVA, P<0.01). When comparing Group I with Group II, succinylcholine had a significantly faster time to 80-90% neuromuscular block than vecuronium (p<0.01) (Figure 1). This also was true when comparing succinylcholine with atracurium. Group I had a significantly faster time to 80-90% twitch depression (p<0.01) than did Group III (Figure 2). There was no significant difference in time to 80-90% twitch depression (Figure 3) between Group II (vecuronium) and Group III (atracurium).

The conditions for intubation were similar for all three groups (Figure 4). Eighty percent of the 30 cases were rated as excellent, 16.7% good and only one case, 3.3%, was rated as poor. None of the patients were evaluated as having achieved inadequate relaxation or as being impossible to intubate.

**Table II**

<table>
<thead>
<tr>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Succinylcholine</td>
<td>55</td>
<td>89</td>
</tr>
<tr>
<td>Vecuronium</td>
<td>103</td>
<td>216</td>
</tr>
<tr>
<td>Atracurium</td>
<td>115</td>
<td>198</td>
</tr>
</tbody>
</table>

**Discussion**

The onset times with atracurium and vecuronium are longer than have been observed previously using the priming principle. Schwarz et al. administered a priming dose of 0.015 mg/kg vecuronium, followed by 0.05 mg/kg six minutes later. They found that the time to intubation was 61±3 seconds compared with 156±12 seconds when administering 0.1 mg/kg vecuronium.

Mehta et al. demonstrated that the onset of neuromuscular blockade is faster when a non-depolarizing neuromuscular blocking drug is preceded by a small dose of the same drug. Their conclusions were statistically significant, and stated that the trachea can be intubated in 60 seconds when administering 0.1 mg/kg vecuronium.

The results of this study seem to agree with those of Gergis and Ramsey. Ramsey et al. stated that a priming dose of 0.05 mg/kg atracurium...
followed five minutes later by 0.35 mg/kg had no effect on increasing the onset of the block, compared with a single intravenous bolus dose of 0.4 mg/kg.

Three patients in this study developed hypotension, while two others experienced wheezing following the administration of atracurium. Potential side effects of atracurium can be prevented by decreasing the speed of administration. No adverse effects were noted in patients receiving succinylcholine or vecuronium.

Conclusion
Succinylcholine had a significantly faster onset to 80-90% neuromuscular blockade when compared with atracurium or vecuronium using the priming principle. Conditions for intubation were similar among all three drugs at 80-90% twitch depression. Further research is necessary to determine an alternative to succinylcholine when it is contraindicated for rapid sequence induction.

REFERENCES
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AUTHORS
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