EFFECT OF STRETCH EXERCISES ON SUXAMETHONIUM INDUCED FASCICULATIONS AND MYALGIA

D. A. MAGEE AND R. J. S. ROBINSON

The speed of onset of blockade and the excellent intubating conditions achieved with suxamethonium are frequently counteracted by muscle fasciculations, increases in intragastric and intraocular pressures (Famewo, 1981) and postoperative muscle pain. Since Churchill-Davidson demonstrated the modifying influence of pretreatment with gallamine in 1954, many forms of pretreatment have been shown to decrease the incidence of these side effects (table I), although none abolishes them totally. Investigation is made more complex since muscle pain is affected by many factors, including the time of ambulation (Churchill-Davidson, 1954), site of surgery (Brodsky and Ehrenwerth, 1980), age (Bush and Roth, 1961), pregnancy (Thind and Bryson, 1983), sex (Riding, 1975), and degree of physical fitness (Newnam and Loudon, 1966).

Stretch exercises performed by athletes before physical effort have the effect, among other things, of decreasing muscle damage during, and diminishing muscle pain after, the actual exercise (Harris, 1984). The aim of this study was to apply stretch exercises to patients undergoing anaesthesia requiring tracheal intubation to determine whether a decrease in the incidence of suxamethonium-induced muscle pain could be achieved.

PATIENTS AND METHODS

The approval of the hospital ethics committee was obtained and each patient gave informed consent before participation. Fifty patients (ASA Class I) presenting for routine minor surgery, and who were expected to be ambulatory on the evening of surgery, were investigated. Subjects were randomly divided into an exercise and a control group. Subjects in the exercise group performed a series of stretch exercises under the supervision of one of the authors (D.M.). The exercises were designed to give a slow, prolonged and repetitive stretching of the muscles of the neck, shoulder

<table>
<thead>
<tr>
<th>Agent</th>
<th>Author</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gallamine</td>
<td>Churchill-Davidson</td>
<td>1954</td>
</tr>
<tr>
<td>Tubocurarine</td>
<td>Cullen</td>
<td>1971</td>
</tr>
<tr>
<td>Self-taming</td>
<td>Baraka</td>
<td>1977</td>
</tr>
<tr>
<td>Dantrolene</td>
<td>Collier</td>
<td>1979</td>
</tr>
<tr>
<td>Thiopentone</td>
<td>Manani and colleagues</td>
<td>1981</td>
</tr>
<tr>
<td>Fazadinium</td>
<td>Famewo</td>
<td>1981</td>
</tr>
<tr>
<td>Lignocaine</td>
<td>Fassoulaki and Kaniaris</td>
<td>1981</td>
</tr>
<tr>
<td>Diazepam</td>
<td>Verma</td>
<td>1982</td>
</tr>
<tr>
<td>Vecuronium</td>
<td>Ferres and colleagues</td>
<td>1983</td>
</tr>
<tr>
<td>Fentanyl</td>
<td>Lindgren and Saarnivaara</td>
<td>1983</td>
</tr>
<tr>
<td>Calcium</td>
<td>Shrivastava and colleagues</td>
<td>1983</td>
</tr>
<tr>
<td>Calcium gluconate</td>
<td></td>
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</tr>
</tbody>
</table>
TABLE II. Grading of fasciculations (Fry, 1975)

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Absent or minimal fasciculations: movements of tongue, corner of mouth or individual digits only.</td>
</tr>
<tr>
<td>II</td>
<td>Moderate fasciculations: facial grimace, movement of hand or rotation of arm.</td>
</tr>
<tr>
<td>III</td>
<td>Severe fasciculations: visible displacement of head or whole limb.</td>
</tr>
<tr>
<td>IV</td>
<td>Maximal fasciculations: purposeful-seeming movement of limb, or generalized clonic contractions.</td>
</tr>
</tbody>
</table>

TABLE III. Sex and age distribution of the groups

<table>
<thead>
<tr>
<th>Group</th>
<th>M</th>
<th>F</th>
<th>M</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exercised</td>
<td>10</td>
<td>15</td>
<td>30.2</td>
<td>35.5</td>
</tr>
<tr>
<td>Control</td>
<td>11</td>
<td>14</td>
<td>30.7</td>
<td>33.6</td>
</tr>
</tbody>
</table>

Each patient was pre-medicated with atropine and a narcotic analgesic 1 h before surgery. Anaesthesia was induced with thiopentone 4.5 mg kg$^{-1}$, followed immediately by suxamethonium 1.5 mg kg$^{-1}$ given over 5 s. After tracheal intubation, anaesthesia was maintained with nitrous oxide in oxygen supplemented with a volatile anaesthetic agent.

Following the administration of the suxamethonium, muscle fasciculations were graded, according to the scale devised by Fry (table II), by the consultant anaesthetist administering the anaesthetic, who was unaware of the subject's treatment group. Each patient was interviewed on the first and second days after operation and was asked to complete a standard questionnaire, the third question of which was “Do you have or have you had any pain in your muscles following your operation?”

The differences between groups were compared using the chi square test or Student’s $t$ test for independent samples. Spearman's rank correlation co-efficient was calculated to test the relationship between exercise, age, sex, the degree of fasciculation, and the presence or absence of muscle pain.

RESULTS

Table III shows the age and sex distribution of the two groups, and the incidence of muscle fasciculations and postoperative muscle pain are given in figure 1. There were no significant differences between the treatment and control groups in the distribution of sexes or mean age. Treated subjects showed significantly less severe muscle fasciculations ($P < 0.001$) and reported postoperative muscle pain less often than control subjects ($P < 0.001$). The incidence of muscle pain was significantly influenced by the severity of fasciculations ($P < 0.01$). The intensity of muscle fasciculation was significantly greater in female
patients ($P < 0.01$), and female subjects had significantly more postoperative muscle pain ($P < 0.01$). There was no relationship between the age of the subjects and either the degree of muscle fasciculation or the presence of postoperative muscle pain.

While conditions for intubation were not specifically investigated, there were no apparent differences between the two groups of patients, and muscle paralysis appeared to be uniformly excellent.

**DISCUSSION**

The continuing interest in new methods of preventing suxamethonium-induced fasciculations and muscle pain reflect both the importance of suxamethonium in clinical practice and the difficulty in preventing these side effects. This study has shown that stretch exercises significantly reduced the incidence of both fasciculations and postoperative muscle pain.

Harris (1984) has shown that muscles are mechanically fatigued and unresponsive following stretch exercises. Muscle tone can be diminished by slow stretching of the muscle where the stretch is maintained over a period of time. The muscle stretch receptors are progressively desensitized as the receptor potential adapts under conditions of prolonged slow stretch. In this way stretch exercises regulate alpha motor neurone discharge through a reduction in the rate of gamma efferent discharge from the muscle spindle. The resulting decrease in muscle tone and increased mechanical fatigue may increase the threshold for motor units, thus altering the action of suxamethonium.

Kitamura and colleagues (1981) have suggested that muscle fasciculations are caused because suxamethonium releases acetylcholine from the prejunctional nerve terminal. In the time interval between stretch exercising and suxamethonium injection (approximately 1 h) there is clearly ample time for regeneration of acetylcholine, since acetylcholine reservoirs are replenished within 3–5 min after rapid exercise (Foldes et al., 1961).

Waters and Mapleson (1971) attributed suxamethonium-induced muscle pain to the development of shearing forces between muscle and fascia. Stretch exercises decrease muscle tone and cause stretch of fibrous tissue (Harris, 1984) and this combination may prevent the development of shearing forces sufficient to damage the connective tissue elements. Waters and Mapleson also showed that there was no relationship between the severity of visible muscle fasciculations and the development of muscle pain, and this finding is confirmed by the results of other workers (Newman and Loudon, 1966; Ferres et al., 1983). This suggests that pretreatment with non-depolarizing myoneural blocking drugs may reduce the incidence of visible fasciculations and muscle pain in different groups of patients. The relationship shown in this study between fasciculations and muscle pain is presumably a consequence of stretch exercises, and the significance of this finding in relation to pretreatment with non-depolarizing neuromuscular blocking agents is not clear.

The increased intensity of fasciculations and the higher incidence of muscle pain in female patients shown here is in agreement with the early findings of Churchill-Davidson (1954) and with subsequent reports (Riding, 1975).

The reported frequency of muscle pain following suxamethonium varies from 1.5% (Crawford, 1971) to 85% (Foster, 1960). Ferres and co-workers (1983) reported an incidence of 41%, which decreased to around 20% after pretreatment with various non-depolarizing neuromuscular blocking agents. Our figures shown an overall frequency of 52%—which decreased to 12% following stretch exercises. The advantages of stretch exercises over pretreatment with non-depolarizing neuromuscular blockers include the avoidance of partial antagonism of the depolarizing blockade, the avoidance of muscle weakness and diplopia, and the avoidance of the theoretical possibility of the development of a mixed neuromuscular blockade.

The major difficulty in the routine application of stretch exercises lies in the time taken, and the personnel required for their supervision. The positive acceptance by patients of these exercises suggests that a high degree of compliance might be achieved by distribution of a simple illustrated leaflet, together with appropriate encouragement by the anaesthetist, to perform the exercises at the time of premedication.

The interval between pretreatment with non-depolarizing neuromuscular blockers and the administration of suxamethonium has been shown to be of importance (Riding, 1975). This study has not examined the time relationship of stretch exercises to suxamethonium administration. A further study is proposed to examine this relationship and to compare the effectiveness of stretch exercises with pretreatment using non-depolarizing neuromuscular blocking agents.
FASCICULATIONS AND MYALGIA: STRETCH EXERCISES

APPENDIX

These instructions were given to patients in the exercise group. Supervision of the exercises was maintained to ensure comprehension of the instructions and compliance.

1. Shoulder stretch (fig. 2). With feet apart extend your arms in front of your body, fingers interlaced. Turn your grip, so that your palms face away from the body, and raise straight arms overhead, forcing them into as much hyperextension as possible. Hold this position for five seconds and then relax for five seconds.
   Repeat five times.

2. Anterior shoulder stretch (fig. 3). With feet apart, interlace your fingers behind your back, and slowly force your arms upwards and backwards as far as possible. Hold this position for five seconds and relax for five seconds.
   Repeat five times.

3. Posterior shoulder stretch (fig. 4). Place your hand behind your neck and with the other hand on your elbow contract by forcing your elbow into your hand. Hold for five seconds and relax gently, stretching your shoulders farther behind your neck. Relax for five seconds.
   Repeat five times.

4. Pectoral stretch (fig. 5). Stand sideways to wall, with your palm against wall slightly above shoulder height. Contract by pushing your palm against the wall, and then relax. Rotate your body away from the wall as far as possible while maintaining hand position, hold for five seconds and relax. Repeat in opposite direction.
   Repeat five times.

5. Trunk rotators (fig. 6). With feet apart and hands on your hips, turn around as far as possible while maintaining foot position. Hold for five seconds and then repeat in opposite direction. Relax for five seconds.
   Repeat five times.

6. Neck muscles (fig. 7). With feet apart, tilt your head sideways forcing your ear as close to your shoulder as possible. Hold for five seconds and repeat on opposite side. Then force your head forwards so that your chin approaches your chest, and hold for five seconds.
   Repeat exercise five times.

ACKNOWLEDGEMENTS

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FIG. 5. Pectoral stretch.

FIG. 6. Trunk rotators.
REFERENCES


