Clearance of bronchial secretions after major surgery
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Stressreaction during endotracheal suctioning

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Submitted.
Abstract

Introduction

Routine endotracheal suctioning (RES) was shown to increase systolic blood pressure and increase pulse-pressure rate suggestive of stress. This study was designed to test the hypothesis that minimally invasive airway suctioning (MIAS) evokes a less pronounced stress response than RES.

Patients and methods

Intubated stable ICU patients were eligible for participation in this study. Exclusion criteria were noradrenaline or adrenaline infusion for the last 24 hours, the use of steroids and age under 55 or over 80 years. All patients underwent one episode of RES and one episode of MIAS, in random order. Arterial blood samples were collected prior to (T0), 1 minute after (T1) and 15 minutes after the suctioning procedure (T15) via an arterial access. After a washout period of three hours the second intervention, either MIAS or RES, was performed. Blood samples were analyzed for noradrenaline, adrenaline and cortisol levels.

Results

In this study, 16 patients were included. Baseline levels of noradrenaline, adrenaline and cortisol were elevated. With RES there were significantly greater noradrenaline and cortisol levels at T1 compared with MIAS. Adrenaline levels were not significantly influenced in either group.

Conclusions

RES caused a significant increase in noradrenaline and cortisol response compared to the MIAS intervention, which suggests that RES leads to higher stress levels. Therefore, RES may be a more stressful intervention than MIAS.

Keywords: Stress - Endotracheal suctioning - Intensive care
Introduction

Endotracheal suctioning for removal of bronchial secretions in intubated patients may be a hazardous procedure. It is performed to maintain airway patency and is believed to prevent pulmonary infections, although evidence for this is lacking. Many complications of endotracheal suctioning have been described including cardiac arrhythmia [1] and oxygen desaturation [2-4]. In a previous study, we found that routine endotracheal suctioning (RES) increases pulse-pressure rate and increases systolic blood pressure suggestive of considerable stress [5]. Elevations in pulse-pressure rate and blood pressure were less pronounced with a new technique, described as “Minimally Invasive Airway Suctioning” (MIAS). With MIAS only the endotracheal tube is succioned with a short catheter and contact with bronchial epithelium is avoided. The present study was designed to test the hypothesis that MIAS results in a less pronounced stress response than RES.

Patients and methods

Stable patients on a cardio-thoracic or general-surgical Intensive Care Unit (ICU) in our University Medical Center were considered for randomisation in this study. Exclusion criteria were noradrenaline or adrenaline infusion for the last 24 hours, the use of steroids and age under 55 or over 80 years. The narrow range of age was chosen to limit variety in hormonal response during the study. All patients underwent a RES and a MIAS treatment. Treatment order was obtained with sealed envelopes. The Medical Ethics Committee of the hospital approved the study protocol. Patients’ relatives gave informed consent to participate in the study. RES and MIAS procedures were performed in a supine position.

RES was defined according to the American Association of Respiratory Care guideline [6]. The patient was disconnected from the ventilator. Manual hyperinflation was performed before a 49 cm (19.3 inch), CH12, catheter
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(Maersk Medical, Denmark) was introduced into the endotracheal tube. Subsequently a negative pressure (200 mmHg) was applied for a maximum duration of three seconds. Manual hyperinflation was applied between suctioning cycles and sterile normal saline (10 ml) was instilled into the endotracheal tube. After three cycles of hyperinflation, saline and suctioning, the patient was reconnected to the ventilator.

MIAS was performed as follows: the patient was disconnected from the ventilator. Subsequently, a 29 cm (11.4 inch), CH12, suction catheter (Maersk Medical, Denmark) was introduced into the endotracheal tube to which a negative pressure (200 mmHg) was applied for a maximum duration of three seconds. The patient was reconnected to the ventilator. Manual hyperinflation was avoided. No saline was instilled. The length of the catheter was chosen to exclude the possibility of the airway being touched by the catheter: it was too short to pass beyond the tip of the endotracheal tube.

Arterial blood samples were collected via an arterial access prior to (baseline, T0), 1 minute after (T1) and 15 minutes after (T15) starting RES or MIAS. After a washout period of three hours the second intervention, MIAS or RES, was performed. Blood samples were then collected at the identical time intervals. Blood samples of 10 ml were analyzed for noradrenaline, adrenaline and cortisol. Blood samples for nor- and adrenaline levels were collected in a specimen tube according to international consensus and were kept on melting ice during transport to the laboratory where the specimens were centrifuged. Blood samples for cortisol levels were collected in a specimen coagulation tube. The analysis of plasm catecholamines was performed as previously described [7,8] using a high-performance liquid chromatography with a electrochemical detection. Serum cortisol levels were determined on an Elecsys 2000 analyser (Roche, Hitachi). Blood samples were also analyzed for arterial blood gasses and glucose levels.

Data on patients’ characteristics, e.g. age, gender, APACHE II score, hemoglobin level, Rikers’ Sedation and Agitation score and current medication, was recorded prior to the interventions.
Statistical analyses

SPSS version 12 was used for all statistical analyses. Descriptive analyses were performed on patients' characteristics. Paired T-tests were performed on the noradrenaline, adrenaline and cortisol values between T0 and T1/T15.

Results

16 Patients were included, resulting in 32 episodes of monitored suctioning. Patients' characteristics are shown in table 1. All patients had a hemoglobin level above 6.0 mMol/l. All patients had a Rikers' Sedation Agitation Score of 2 to 4 and the score did not change during the RES and MIAS interventions.

Table 1. Patients' characteristics.

<table>
<thead>
<tr>
<th>Type of patient</th>
<th>Medical:</th>
<th>Surgical:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, mean (SD) in years</td>
<td>66.9 (6.9)</td>
<td></td>
</tr>
<tr>
<td>Gender, male in %</td>
<td>75</td>
<td></td>
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</tbody>
</table>

Non-significant differences were reported between the baseline (T0) values of RES or MIAS in table 2. All patients returned to baseline levels before the second intervention (data on individual patients not shown).
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Table 2. Baseline and reference values.

<table>
<thead>
<tr>
<th></th>
<th>Baseline values at T0 Mean (SD)</th>
<th>Reference values Upper Range Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Noradrenaline, in nMol/l</td>
<td>3.27 (1.83)</td>
<td>1.84</td>
</tr>
<tr>
<td>Adrenaline, in nMol/l</td>
<td>0.65 (0.99)</td>
<td>0.17</td>
</tr>
<tr>
<td>Cortisol, in nMol/l</td>
<td>556 (212)</td>
<td>400</td>
</tr>
</tbody>
</table>

To evaluate the changes in RES and MIAS, differences were calculated between baseline (T0), one minute post treatment (T1), and 15-minutes post treatment (T15) in RES or MIAS and plotted in error bars in standard error of the mean (figures 1 to 3).

Mean arterial Pressure (MaP) increased significantly during suctioning and more so after the RES treatment (13 mmHg) compared to the MIAS treatment (3 mmHg, P value 0.030).

The immediate rise in noradrenaline and cortisol levels (T1-T0) was significantly greater in the RES group than in the MIAS group (figures 1 and 3). At 15 minutes no significant differences were found between both groups as to increase from baseline (T15-T0). Adrenaline levels did not increase in either group (figure 2).

Glucose levels, PaO2 and PaCO2 did not change during the measurements (data not shown).

Figure 1: +/- Standard Error of Mean of change in noradrenaline in nMol/l (* P < 0.005)
Discussion

The results of our study show that RES leads to an increase of stress hormones which is higher than the increase observed in MIAS. This suggests that, by reducing the RES procedure into a minimally invasive procedure, a reduction in stress response could be achieved.
No significant differences were found in adrenaline responses of the RES intervention compared to the MIAS intervention. This finding could be explained by the fact that baseline levels of adrenaline were already elevated to more than 350% of the Upper Range Limit of the normal level. Perhaps this level of adrenaline could not increase any further. Adrenaline is produced in the adrenal medulla and most of the noradrenaline is produced in the sympathetic nerves and is then released into the bloodstream [12]. Perhaps the production of stress hormones in the adrenal medulla did not respond to the stimulus anymore, while the sympathetic nerve endings could still contribute to the response and produce the required release of noradrenaline.

Baseline catecholamine values during prolonged duration of intubation were increased as compared to healthy subjects, which indicate that these patients were in a stressful condition. Our data thus confirm reports in the literature that patients recall the period of ICU/intubation as a very stressful period [9-11].

The stress of the suctioning procedure is further reflected in a rise of MaP. The MIAS intervention resulted in a lower increase of MaP, as compared to traditional RES.

This study looked at stable ICU patients in a limited range of age. It remains to be investigated whether similar results will be found in less stable patients, younger patients or the very old population on the ICU. Therefore outcome of this study is limited to the range of the age investigated.

**Conclusions**

In summary RES causes a significant increase in noradrenaline and cortisol response compared to the MIAS intervention. The difference in adrenaline response is non-significant comparing the two interventions. Baseline catecholamine levels in ICU patients are elevated compared to healthy subjects. Extra release of stress hormones during endotracheal suctioning can probably be avoided by opting for a minimally invasive suctioning strategy.
Reference list

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